Design, Fabrication, and Test of an Electromechanical Propellant Control Actuator for Redundancy Studies of Multiwinding Motor Concepts

Project Number: 97-03

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Purpose

The purpose of this effort is to further investigate redundancy implementation in propellant control valve (PCV) electromechanical actuators (EMA). To date, a simplex PCV EMA has been successfully demonstrated in the laboratory. A dual redundant configuration has also been tested. This two-channel unit utilizes two electric motors and uses pneumatics to achieve an equivalent redundancy level to the comparable hydraulic unit, yet due to its motor scheme is not weight competitive. The major thrust of this effort is to characterize the benefits that a multiwinding motor would provide in optimizing the redundancy scheme, thus optimizing the entire PCV EMA. This technology should provide both weight and performance benefits, while adding to the already advantageous low maintenance and operations costs of EMA technology.

Background

New engine control system designs must be developed to address the challenging goals for the next generation reusable launch vehicle. Designs will need to be driven by cost savings relating to performance, weight, reliability, operations and maintenance. EMA's show great potential in reducing operations and maintenance costs due to the replacement and enhancement of hydraulic systems. A key issue in making the EMA competitive in weight and performance is redundancy configuration. This technology represents benefits essential to the success of the next reusable launch vehicle.

Approach

The approach taken to investigate multiple winding motor designs for EMA redundancy implementation is to design and build an actuator utilizing off-the-shelf components, where possible, incorporating a dual winding motor. The envelope will be considered in packaging. The EMA will be designed to provide fail-safe redundancy. Off-the-shelf controllers will be integrated with the system.

System tests will be conducted in MSFC's Control Mechanisms Lab, Building 4656. Testing will concentrate on failure tolerance of the actuator in both operational and failed modes. Various tests will include failing of one motor winding (channel), then characterizing the fail-safe performance capability of the design.

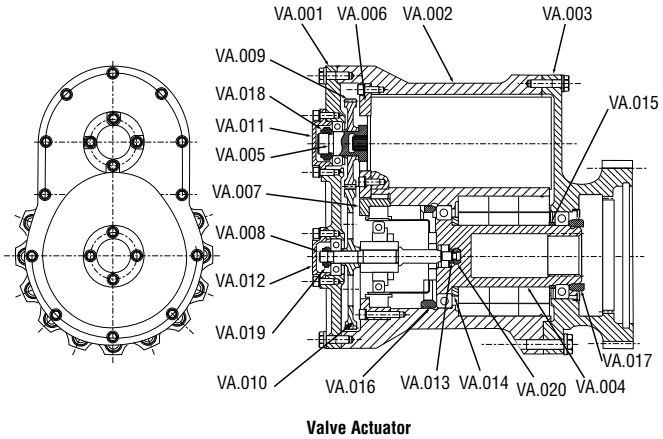

FIGURE 15.—Electromechanical propellant control valve actuator assembly section view.

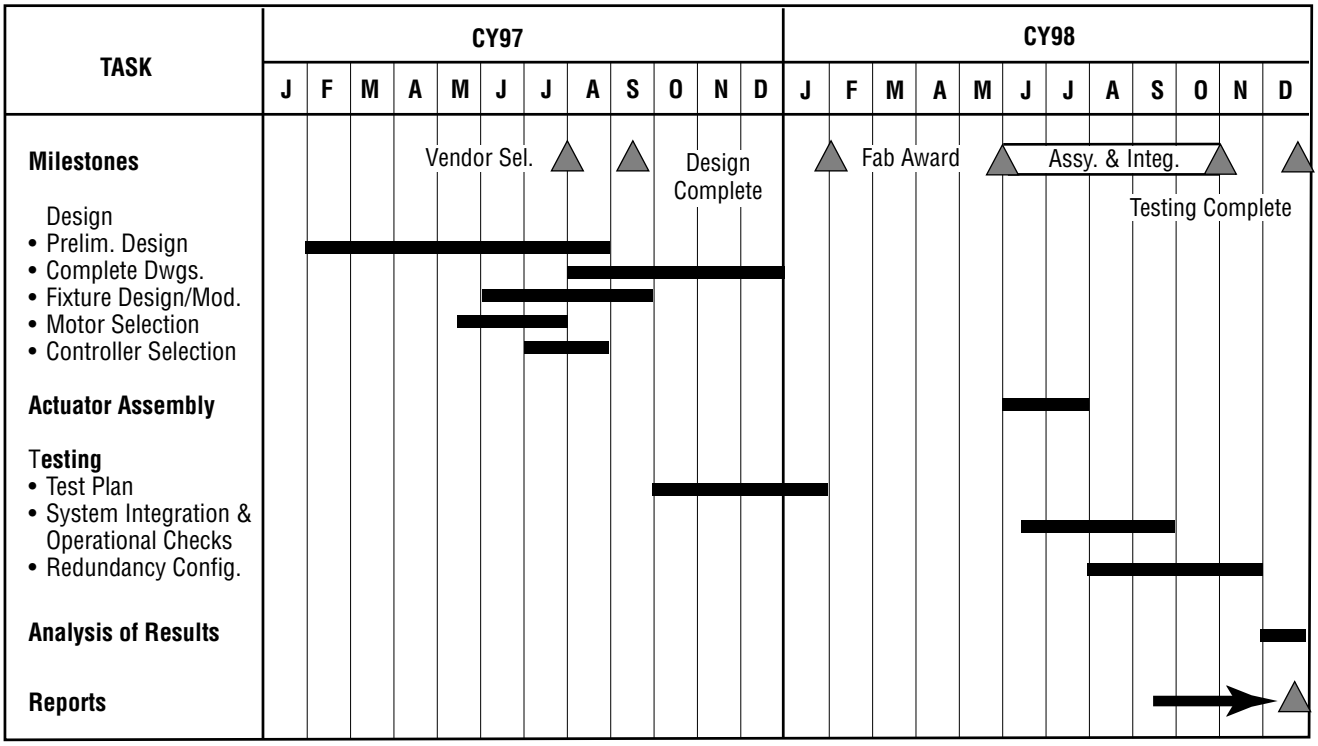

FIGURE 16.—Schedule/milestone chart.

Accomplishments

- Assembly drawing pending motor solicitation (95 percent complete)
- Detail drawings in work
- All major off-the-shelf components (motors, harmonic drives, resolvers, bearings, controller electronics) on order
- 1997 money spent.

Planned Future Work

- Complete detail drawings
- Contract machined parts
- Software generation for redundancy implementation (Labview)
- Testing (majority vote, active stand-by, active out, etc.).

Funding Summary ($k)

	FY97	FY98
Authorized by letter:	100	50
Obligated to date:		
Actuator:		
Electric Motors	28.15	
Resolvers	21.33	
Harmonic Drives	1.85	
Bearings	0.59	
Electronics:		
Power hybrid modules	24.40	
Miscellaneous (amplifiers, printed circuit boards, power supplies, digital signal processors, analog/digital cards, digital/analog cards, resistors, capacitors, connectors)	23.68	
Total $	0	

Status of Investigation

Project approved—January 23, 1997
Estimated completion—January 1999